Waste: A Potential Source of Energy for the United States Air Force Academy

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Overview

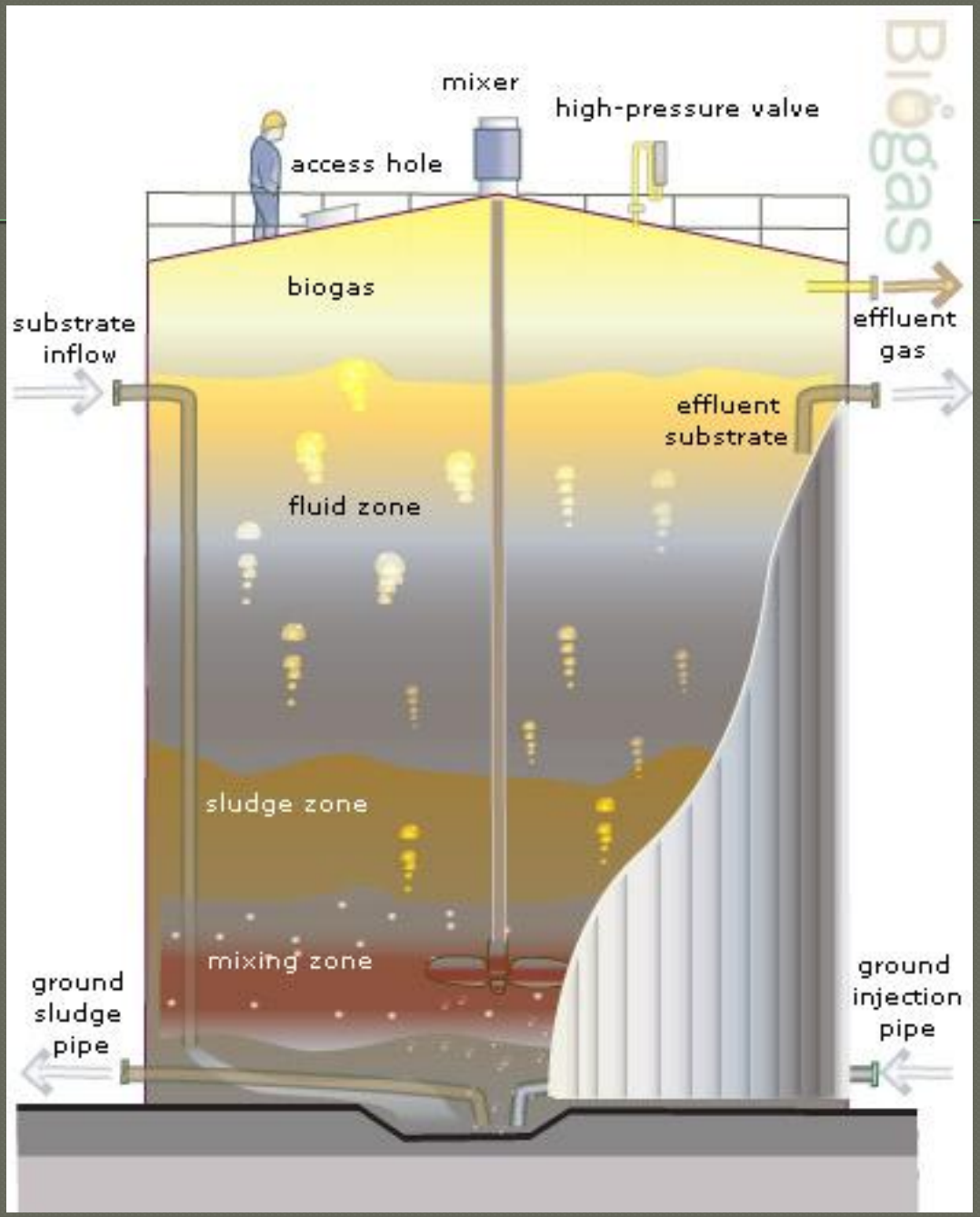
- Intent
- Technology
- Scope
- Cost
- Obstacles

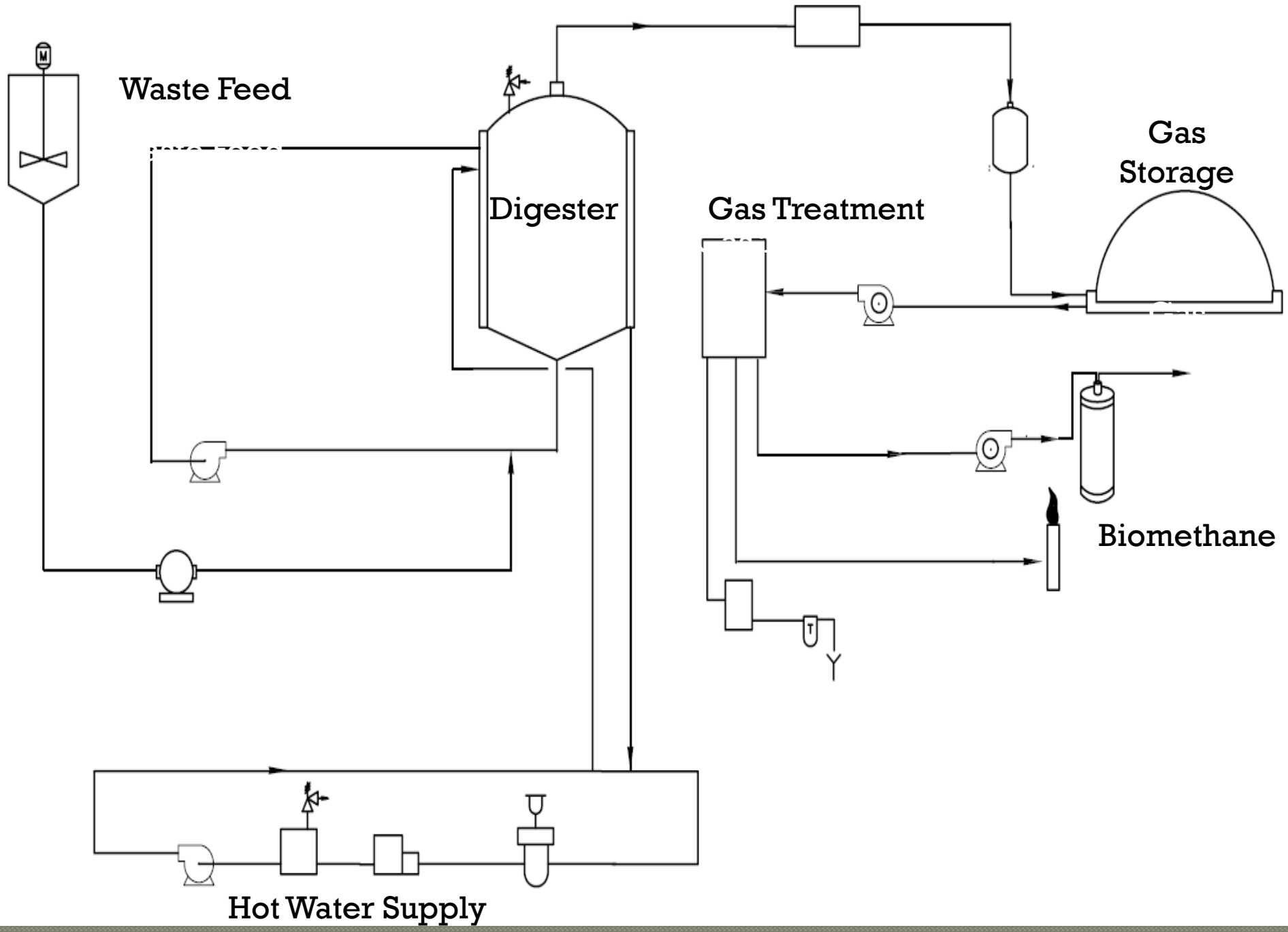
Intent

- Reduce the volume of trash disposed of
- Alternative source of energy
- USAF Academy: Net zero installation by 2015
- Energy Policy Act of 2005: 7% of electricity be renewable by 2013

Technology

- Anaerobic Digestion
  - Sensitive to pH change
  - Troubles treating MSW
  - Lower volume reduction
  - Could be used in conjunction with Downdraft Gasification


Biogas
mixer
high-pressure valve
access hole
biogas
substrate inflow
effluent gas
effluent substrate
fluid zone
sludge zone
mixing zone
ground sludge pipe
ground injection pipe

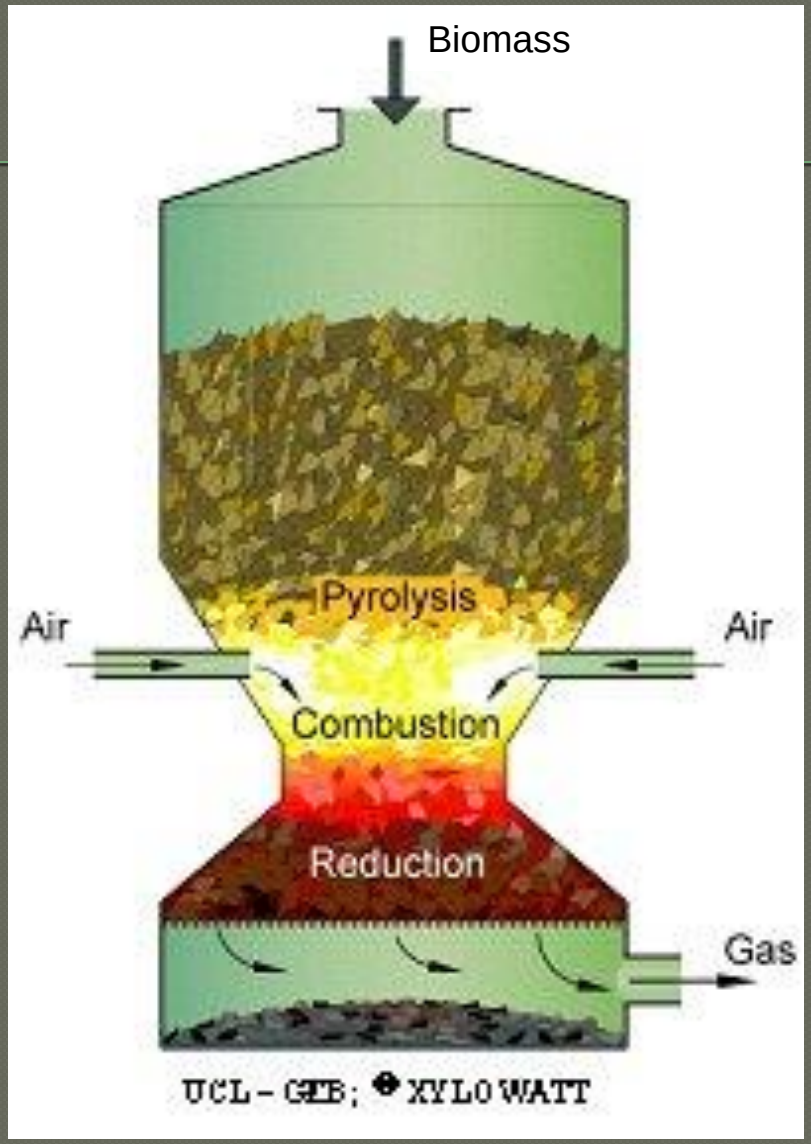

Waste Feed
Digester
Gas Treatment
Gas Storage
Biomethane
Hot Water Supply

Technology

- Gasification
  - Accepts MSW and sludge
  - Requires a drier and waste conditioner
  - Affects of waste stream properties
    - Moisture Content
    - Size and shape
    - Density
    - Chemical Composition

Technology

- Gasification
  - Produces a gas rich in CO, CO_2, H_2, hydrocarbons
  - Operates at 800-1100˚C
  - Approximately 95% reduction in volume
  - Efficiency affected by ash and char production


Biomass
Pyrolysis
Air
Air
Combustion
Reduction
Gas
UCL - GEB; XYLOWATT

Technology

- Waste Conditioning: Paralysis
  - Temperature ranges from 300-700° C
    - 400°C optimal due to plastic decomposition at higher temperatures (Swithenbank)
  - Produces
    - Char: high in carbon that can used in gasification
    - Gas: Containing Hydrocarbons, CO, CO_2
    - Oil/liquid: aromatic groups, ketones, alkanes

Benefits

- Reduction of high water content waste to landfill
  - Reduced leachate formation
  - Preserves groundwater quality
- Extend life of existing landfills
- Reduction of methane emissions from landfills
- Reduction of greenhouse gas emissions
- Biogas production

Scope

- Anaerobic Digestion
  - 40 to 65% reduction in waste volume
  - 500 to 600 tons of food waste/year
    - Includes waste cooking oil
  - Produces approximately $90/ton of biogas

Scope

- Gasification
  - 11.65 tons of non-hazardous waste
  - 600 lbs of sludge
  - 11.15 tons of recycled waste
  - Generation Rates
    - 14 kilowatts of energy per ton
    - 34 thermal kilowatts per hour per ton
  - 163 kilowatts of energy/year (40% redirected)
  - 396 thermal kilowatts/year (18% redirected)

Cost

- Anaerobic Digestion
  - Can not quote due to ongoing negotiations
- Gasification (estimated start up cost)
  - $170,000 per ton of waste
  - $2.08 million total
  - Payback period of approximately 13.5 years

Obstacles

- Detailed budget
  - Analysis of actual output numbers
- Analysis of feedstock and efficiency for each process
- Permitting
- Odor Control
- Contracting a company

Special Thanks

- IST Energy
  - Creator of the "Green Machine"
  - Provided valuable information on gasification and integrating it into the waste management cycle
- Camp Dresser & McKee Inc and ESTCP
  - Information on anaerobic digestion
  - Currently working with the Academy on pilot scale test
- Advisors and Professors at the Academy
  - Dr. Pocock

Sources

- Emails from IST Energy and Mr. Hume
- "The Green Machine." 23 Nov. 2009. www.Istenergy.com
- Srividhya P.K., C. Muraleedharan, and S. Jayaraj. "Fuel Characteristics and Gasification of Woody Biomasses in Down Draft Gasifiers." International Review of Mechanical Engineering. Vol 2 (2009): 126-132
- Malik A., S. Naveed, M. Akram, and N. Ramzan "Fixed Bed Gasification of Steam Treated Food Waste and Municipal Solid Waste"
- Ryu, Dr. C. "Waste Paralysis and Generation of Storable Fuel" The Onyx Environmental Trust. (2005)